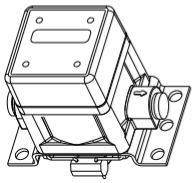
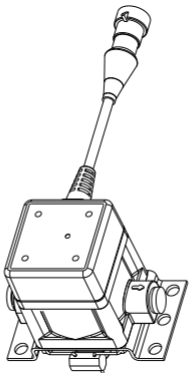
DFM®

FUEL VIEW

Fuel Flow Meters



DFM 50C
DFM 100C
DFM 250C
DFM 500C



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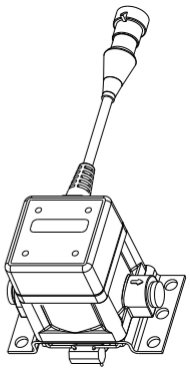
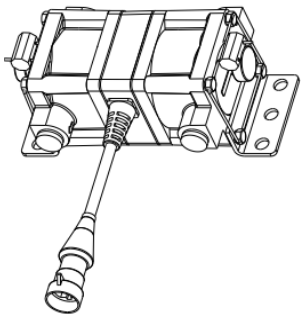
DFM 250AK
DFM 500AK



DFM 50CK
DFM 100CK
DFM 250CK
DFM 500CK



DFM 100D
DFM 250D
DFM 500D

OPERATION MANUAL

Mass Flow ONLINE

Version 2.0

003 E20 АГ17 НО06

TECHNOTON

Contents

Introduction

Recommendations and regulations given in the Operational Manual are related to **DFM fuel flow meters** (hereinafter referred to as DFM), marketed by Mass Flow ONLINE BV and developed by Technoton JV, Minsk, Belarus. This document contains information about design, principle of operation, DFM data, and recommendations on the operation and installation.

DFM® is a precision tool to measure fuel consumption.

DFM features:

- **conformity to domestic and European automotive standards**;
- **protected from unauthorized tampering and "cheating"***;
- **fuel consumption time tracking** — general consumption and in various modes;
- **integrated filter**;
- **minimum resistance to fluid flow**;
- **100 % of manufactured DFMs are being verified** at a certified metrological installation;
- **great operating experience**;
- **high-quality technical support**;
- **affordable price**.

ATTENTION! When operating the DFM the manufacturer's recommendations set forth in this operational manual must be adhered rigorously. .

The operation manual is intended for professionals who are familiar with repair and installation rules on vehicles, and who are experts in the field of electrical and electronic equipment of various vehicles.

In order to ensure proper functioning of the DFMs, their installation and adjustment has to be carried out by certified professionals.

* Models DFM AK, DFM C, DFM CK, and DFM D.

Order identity code is being formed in accordance with Figure 1:

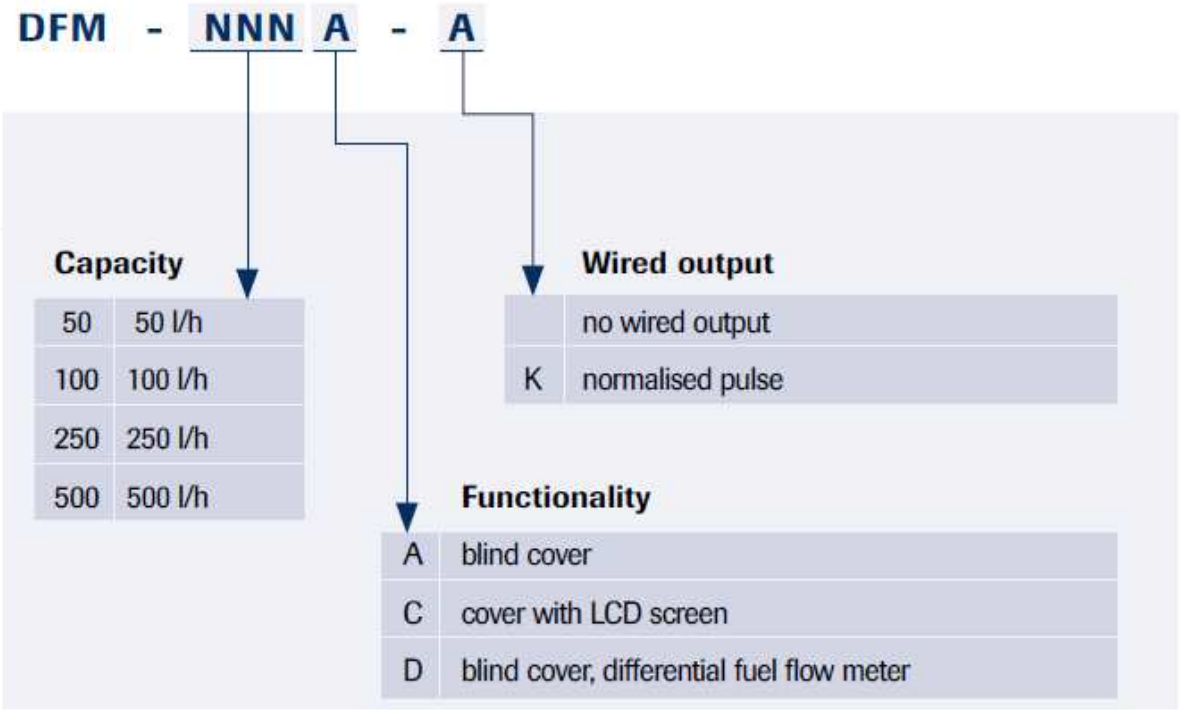


Figure 1 — DFM identification code for an order

Examples of DFM identity codes writing when ordering:

"DFM fuel flow meter 50C",
(Max consumption — 50 l/h; model — with LCD display).

"DFM fuel flow meter 100AK",
(Max consumption — 100 l/h; model — without display;
electronic interface — normalized pulse).

ATTENTION! The manufacturer reserves the right to change DFM specifications that do not deteriorate consumer qualities without customer consent.

1 Basic information and technical specifications

1.1 Purpose of use

DFM® are designed to measure fuel consumption of vehicle and stationary installations.

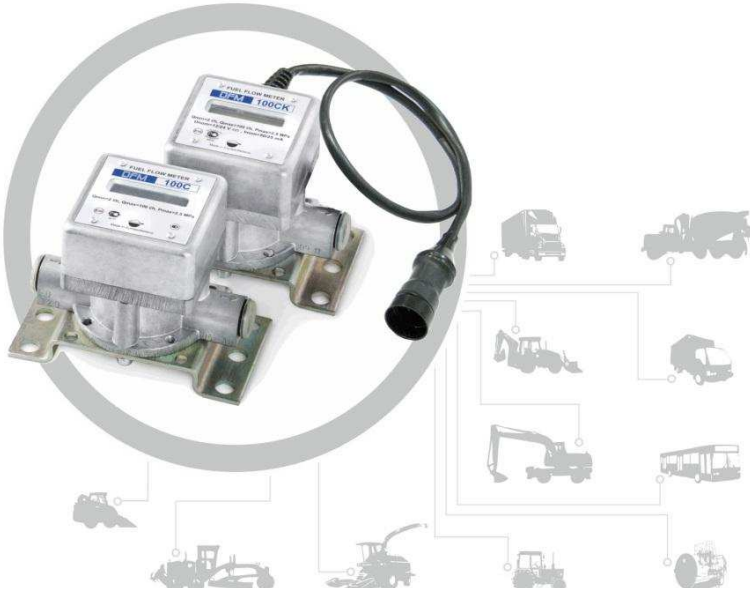


Figure 2 — DFM use

Use of DFM provides vehicle owners with the following:

- **Actual fuel consumption records;**
- **Time tracking of the machinery work;**
- **Fuel rationing;**
- **Fuel theft detection and prevention;**
- **Real-time monitoring and fuel consumption optimization;**
- **Engine tests for fuel consumption.**

1.2 Exterior view and delivery set

DFM delivery set is shown in Figure 3 and includes the following:

1	Assembled fuel flow meter	– 1 pc.;
2	iButton key*	– 1 pc.;
3	Pilot cable, 7.5 m**	– 1 pc.;
4	Verification certificate	– 1 pc.;
5	Registration certificate	– 1 pc.

Figure 3 — DFM delivery set

* for fuel flow meters with display.
** for DFM with interface output.

1.3 DFM varieties

The following **types** of DFM fuel flow meters exist:

1) Single-chamber fuel flow meters measure the volume of fuel that flows in the line.
The following models of **single-chamber fuel flow meters** are being produced:

- **DFM C** — fuel flow meters with display;
- **DFM CK** — fuel flow meters with display and interface output;
- **DFM AK** — fuel flow meters with interface output.

2) Dual-chamber fuel flow meters measure fuel consumption as the difference in volume of fuel flowing through the supply and return fuel lines.
The following **dual-chamber fuel flow meters** are being produced:

- **DFM D** — differential fuel flow meters with interface output.

1.3.1 DFM C models

DFM C (fuel flow meters with display) (see Figure 4) serve to build the fuel monitoring system in a vehicle company without additional hardware and software.

Figure 4 —DFM C exterior

Fuel consumption and vehicle operating time is displayed on the LCD of the DFM (hereinafter referred to as display). Monitoring and recording is to be performed visually, copying out the data into a fuel timesheet, by a responsible person.

1.3.2 DFM CK model

DFM CK Model (fuel flow meter with display and interface output) (see Figure 5) can work both independently and as a part of automated fuel consumption control and vehicle monitoring system.

Figure 5 —DFM CK exterior

Fuel consumption and vehicle running time is displayed. In addition, fuel consumption information is given to the pulse output.

1.3.3 DFM AK models

DFM AK models (fuel flow meter with interface output) (see Figure 6) serve to measure fuel consumption as a part of automated fuel consumption control and vehicle monitoring system *****.

Figure 6 —DFM AP and DFM AK exterior

DFM AK models do not have displays but they have LED indicator on their covers. Flashing light signal indicates that there is given an output pulse signal containing information on vehicle fuel consumption.

***** In combination with fuel consumption indicators, DFMs can be used independently (see 2.8.3).

1.3.4 DFM D model

DFM D model (differential fuel flow meter) (see Figure 7) is used in vehicle fuel consumption monitoring systems installed in automotive and tractor machinery with modern EURO (TIER) 3/4/5***** diesel engines.

Figure 7 —DFM D exterior

A differential fuel flow meter calculates fuel consumption as the difference of the fuel flows of the supply and return fuel lines. Vehicle fuel consumption information is sent to the pulse output.

***** In combination with fuel consumption indicators, DFMs can be used independently (see 2.8.3).

1.4 Measurement range and precision

Table 1 — Measurement range and precision

Model	Starting consumption**, l/h	Min consumption, l/h	Max consumption, l/h	Relative error, %, no more than
DFM 50AK **DFM 50C** **DFM 50CK**	0.5	1	50	±1
DFM 100AK **DFM 100C** **DFM 100CK**		2	100	±1
DFM 250AK **DFM 250C** **DFM 250CK**	2	5	250	±1
DFM 500AK **DFM 500C** **DFM 500CK**	5	10	500	
DFM 100D	0.5*	10*	100*	±3
DFM 250D	2*	25*	250*	
DFM 500D	5*	100*	500*	

* Consumption in each chamber.
** Minimum consumption threshold value when the fuel flow meter begins to work (indicated for reference, fuel consumption measurement error at the startup is not standardized).

ATTENTION!
If the measurement value of the average fuel consumption of the vehicle is close to the upper limit of a certain DFM model, it is recommended to choose a DFM model with higher rating values. That will ensure absence of a fuel flow meter's influence on the fuel system as well as longer DFM operating life.

1.5 Unit structure and operation principle

DFM consists* of a ring-type measurement chamber **1,** a top cover **2** with a microprocessor board inside, a bracket **3**, and an interface cable with plug connection **4**.

Figure 8 —DFM components

DFMs refer to devices of direct volumetric measurement of the fuel consumption with ring-type measurement chambers.

The principle of DFM operation is based on measuring fuel volume that passes through a measurement chamber. Under pressure of the fluid flowing through the fuel flow meter inlet nozzle to the inlet of the measuring chamber, the ring slides along the inner surface of the chamber and it also slides along the web. The ring pushes the fluid inside and outside the chamber out through the outlet into the outlet nozzle. (see Figure 9).
One turn of the ring pushes out the volume of fluid equal to the volume of the chamber. At the same time the electronic board of the DFM makes one outlet pulse.

Figure 9 — The scheme of DFM measuring chamber work

***** The structure is presented by the example of a single-chamber DFM with display and interface output.

Distinctive design features of DFM fuel flow meters:

- DFM structure allows the fluid flow even if the ring is fixed (for example due to chamber clogging);
- Special coating of the ring ensures its durability and wear resistance;
- The measuring chamber is made of durable and lightweight zinc-aluminium (ZA) alloy;
- A mud filter effectively protects the working chamber from fouling. The filter can be removed and cleaned without disassembling the DFM body;
- M14x1.5 and M16x1.5 nozzles allow mounting the DFM on any automotive vehicles without adapters;
- A large flow passage minimizes hydraulic resistance to the fuel flow;
- An improved magnetic circuit reduces sensitivity to hydraulic shocks in the fuel system of an engine.

1.6 Technical specifications

1.6.1 Working fluids

DFM can measure consumption of the following kinds of fluids:

- Diesel fuel (GOST 305, STB 1658);
- Furnace oil (GOST 10585);
- Fuel oil (GOST 10585, STB 1906);
- Motor fuel (GOST 1667);
- Admiralty and furnace fuel oil (GOST 10585);
- Biofuel (GOST R 52808, STB 1658);
- Other liquid fuels and mineral oil with kinematic viscosity of 1.5 to 6 mm^2/s.

ATTENTION!

1 All DFMs are tested with diesel fuel.

2 When working with fluid with kinematic viscosity more than 6 mm^2/s, the top limit of DFM measuring range is below the standardized, and pressure drop in the fuel flow meter is higher.

3 The size of inclusions in the liquid must not exceed 0.08 mm.

4 DFM fuel flow meters are made of materials resistant to gasoline. However when operating with gasoline the declared lifetime of the measuring chamber of the flow meter is not guaranteed (see 1.6.3).

1.6.2 Main specifications

Main DFM characteristics are shown in Table 2.

Table 2 — DFM main characteristics

Parameter, measuring unit	Value
Max pressure, MPa	2.5
Nominal pressure, MPa	0.2
Nominal filtering degree of measured fluid, mm, not less than	0.08
Connecting thread	M14x1.5 M16x1.5*
Pressure drop at maximum fuel consumption, nominal pressure, diesel fuel at 20 °C, MPa, not more than	0.02
Voltage range of the power supply, V	from 10 to 50
Current consumption at 12 V, mA, not more than	50
Current consumption at 24 V, mA, not more than	25
Environment operating temperature range, °C	from -40 to +80**
Environment relative humidity at t 40 °C, %, not more than	95
Vibration resistance	Max. acceleration to 100 m/s^2 in the frequency range from 5 to 250 Hz (GOST 3940, GOST R 50607)
Resistance to aggressive environments	Oil and gasoline resistance (GOST 3940, GOST R 52230)
Electromagnetic compatibility	ESD protection, degree of fixity II (GOST 30378, GOST R 50607); protection against conducted interference, degree of fixity IV (STB ISO 7637-2, GOST 28751).
Boundary dimensions	See Appendix A
Weight	

* In the standard series of DFM 500 fuel flow meters.

** The data is displayed in a range of environment temperature from -20 to +60 °C.

1.6.3 Specifications of measurement chambers

Table 3 — Specifications of measurement chambers

Model	Nominal diameter (Dy), mm	Nominal volume of the measuring chamber, ml	Operational life of the measuring chamber*, l
DFM 50AK **DFM 50C** **DFM 50CK**	6	5	70000
DFM 100AK **DFM 100C** **DFM 100CK** **DFM 100D**			
DFM 250AK **DFM 250C** **DFM 250CK** **DFM 250D**	8	12,5	175000
DFM 500AK **DFM 500C** **DFM 500CK** **DFM 500D**	12	20	350000
***** When the operational life of the measuring chamber is finished, contact the service center to check the fuel flow meter.			

1.6.4 Power supply modes

DFM fuel flow meters can operate in the following power supply modes:

External power supply (**DFM D** models) — DFM operation is provided by external power supply (e.g. onboard power supply of the vehicle).

Self-contained power supply (**DFM C** models) — DFM operation is provided by an integrated lithium-silicon battery. Estimated duration of the DFM operation until full battery discharge is not less than 24 months.

Combined power supply (**DFM AK** and **DFM CK** models) — DFM operation is provided by external power supply or by an integrated battery (if onboard power supply is switched off). In addition, self-contained power supply switches on in case of low onboard voltage (less than 10 V). Estimated duration of DFM operation with onboard power off until full battery discharge is not less than 24 months.

ATTENTION! When **DFM AK** and **DFM CK** are supplied by integrated battery pulse signal is not sent to the interface output. For **DFM CK** model it is possible to copy data from display in the amount in accordance with Table 5.

DFM AK and **DFM CK** fuel flow meters have the **function of recording the data on fuel consumption when onboard power is off**. When onboard power is on, the electronic board of the fuel meter sends a higher frequency pulse (the frequency is approximately 2 times higher than an output pulse during maximum fuel consumption). That signal contains all pulses counted when external power supply was off.

1.6.5 Operation modes

Table 4 — Operation modes of the fuel flow meters

<table>
<tr><th colspan="3">Engine operation</th><th rowspan="3">Tampering
$Q>Q_{max}$</th><th rowspan="3">Interference
The impact of constant magnetic field more than 5 seconds</th></tr>
<tr><th colspan="3">Normal consumption
$0<Q\leq Q_{max}$</th></tr>
<tr><th>Idle run
$0<Q<2.5Q_{min}$</th><th>Optimal run
$2.5Q_{min}\leq Q<0.75Q_{max}$</th><th>Overload
$0.75Q_{max}\leq Q\leq Q_{max}$</th></tr>
<tr><td colspan="5">Q — instantaneous fuel consumption.
Q_{min} — the lower limit of the measuring range.
Q_{max} — the upper limit of the measuring range.</td></tr>
</table>

1.6.6 Displayed data

DFM models with display are marked with letters **C,** and **CK** (see Introduction, Figure 1).

Display information switching is performed by 1-2 seconds light touch to the top cover of the fuel flow meter by iButton key (see Figure 10).

Figure 10 — Switching information screens

In order to save the charge of the built-in battery the DFM display goes to sleep mode one minute after the last touch of the cover by the iButton. At the same time dots are shown on the display (see Figure 11).

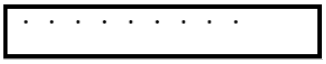


Figure 11 — Display view in sleep mode

When next time the display is touched it wakes up and shows information again.

Table 5 — DFM display information screens

Screen No.	Displayed Data	Digit Capacity	Unit	Model	
				DFM C	DFM CK
1	Total Fuel Consumption counter	0.1	l	+	+
2	Total Fuel Consumption, High Accuracy Data counter	0.001	l	+	+
3	Engine Operation Time counter	0.1	h	+	+
4	Engine Operation Time in Idle Run Mode counter	0.1	h	+	+
5	Engine Operation Time in Optimal Run Mode counter	0.1	h	+	+
6	Engine Operation Time in Overload Mode counter	0.1	h	+	+
7	Fuel Consumption in Tampering Mode counter	0.1	l	+	+
8	Interference Time counter	0.1	h	+	+
9	Instantaneous Fuel Consumption	0.1	l/h	+	+
10	Battery Charge in Percentage of the Maximum	10	%	+	+
11	Temperature in the Measuring Chamber	1	°C	+	+
12	Firmware Version (X.X) and Chamber Volume (У)	—	—	_У X.X	≡У X.X

Screen 1 displays the counter reading **Total Fuel Consumption** (the accuracy to within 0.1 l) accumulated since the DFM release.

Screen 2 displays the counter reading **Total Fuel Consumption, High Accuracy Data** (the accuracy to within 0.001 l) accumulated since the DFM release.

Screen 3 displays the counter reading **Engine Operation Time** accumulated as the total time of engine operation in all modes including idle run.

Screens 4, 5, and 6 display the counter readings of **Engine Operation Time In Idle, Optimal and in Overload Modes** accumulated by DFM as a total engine operation time in corresponding modes (see 1.6.5).

Screen 7 displays the counter readings of **Fuel Consumption In Tampering Mode** accumulated by DFM measured as the amount of fuel higher than maximum consumption (see 1.6.7). Value increase of this counter indicates the incorrect installation of the fuel flow meter or possible facts of fuel theft.

Screen 8 displays the counter reading **Interference Time** accumulated by DFM as the total time of exposure to external factors (strong magnetic field). Increase of the values of this counter may indicate an installation of the fuel flow meter near a source of strong electromagnetic radiation or deliberate attempts to lock the fuel meter (see 1.6.7).

Screen 9 Instantaneous Fuel Consumption displays current value of fuel consumption. It can serve for a visual check of device operability and its correct installation.

Screen 10 Battery Charge in Percentage of the Maximum displays the value of remaining charge of integrated battery.

Note — When the environment temperature is below 10 °C, displayed value of remaining charge can decrease by 10-30 %.

Screen 11 Temperature in the Measuring Chamber displays current temperature value in the measuring chamber of the fuel flow meter.

Screen 12 Firmware Version and the Chamber Volume displays the firmware version installed on the fuel meter, as well as the exact volume of the measuring chamber.

1.6.7 DFM protection from tampering and intervention

In order to prevent false readings of the fuel flow meter, its damage or locking, DFM models with display (**DFM C,** and **DFM CK**) have the following protection modes against malicious acts by third parties:

1) Tampering Mode is to protect from tampering with the purpose to increase fuel consumption metering (for example by blowing air). Tampering usually causes sharp increase in fuel consumption exceeding maximum. DFM electronic board registers increased fuel consumption while the fuel meter work suspends, and tampering meter activates which

registers the volume of fuel flown through the fuel meter at higher speed.

Tampering Mode the screen displays dashes (see Figure 12).

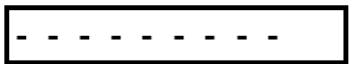


Figure 12 — Display view in Tampering Mode

Exiting the Tampering Mode is automatic in a few seconds after the conditions of the fuel meter work return to normal.

2) Interference Mode is made to protect DFM from magnetic field impact with the purpose to stop fuel counting or to tamper readings of fuel consumed. When exposed to external magnetic field, DFM registers an attempt of interference, and as the result increment of all the counters stops, and the time of exposure counts in a special counter as Interference Time.

In the Interference Mode, the display reads vertical strokes (see Figure 13).

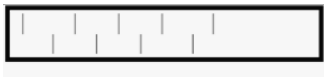


Figure 13 — Display view in Interference Mode

Exiting the Interference Mode is automatic in a few seconds after the conditions of the fuel meter work return to normal.

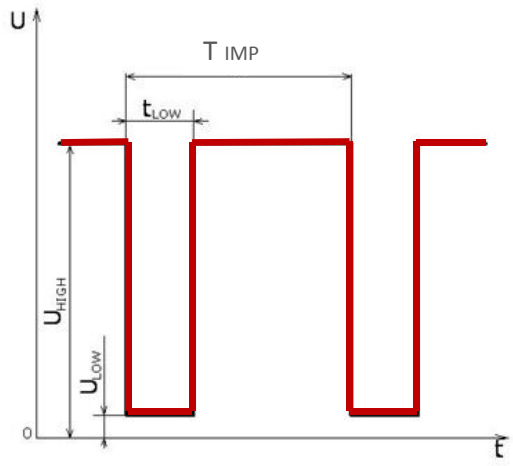
3) Independent Power Supply Mode, for **DFM AK** and **DFM CK** models, when external power supply is off models(vehicle onboard power supply), the integrated battery provides autonomous independent work of the fuel meter.

4) Junction Sealing — original DFM accessories (fuel connectors, valves, etc.) have **openings for sealing** which allow to detect the facts of tampering with the fuel system after installation of the meter.

1.6.8 Specifications of output pulse signal of the DFM with interface output

Fuel flow meters with **normalized pulse** (**DFM AK, DFM CK,** and **DFM D** models) generate certain number of pulses, indicated in registration certificates, for 1 liter fuel $\mathbf{N}_{pulse/l}$ (see Table 6).

Normalized pulse signal view is shown in Figure 15.



$U_{HIGH} = U_{WATT}$
$U_{LOW} = 0.7$ V
t_{LOW} and T_{pulse} (see Table 6)

Figure 15 — Normalized pulse signal view of DFM AK, DFM CK, and DFM D models

Table 6 — Parameters of normalized pulse of DFM AK, DFM CK, and DFM D models

Model	T_{pulse}, ms	t_{LOW}, ms	$N_{pulse/l}$, pcs
DFM 50AK **DFM 50CK**	from 360 to 18000	80	200
DFM 100AK **DFM 100CK**	from 180 to 9000		
DFM 100D	from 200 to 36000	from 100 to 500	
DFM 250AK **DFM 250CK**	from 180 to 9000	80	80
DFM 250D	from 200 to 90000	from 100 to 500	
DFM 500AK **DFM 500CK**	from 144 to 7200	80	50
DFM 500D	from 180 to 144000	from 54 to 500	

1.7 DFM compatibility with terminals

Technoton guarantees full compatibility and joint accuracy of fuel consumption measurement of DFM and CKPT 45, CKPT 25, CKPT 21 and CKPT 31 terminals.

Additional information on DFM use in CKPT® vehicle tracking and fuel monitoring system as well as the range of CKPT terminals and their specifications are presented at www.jv-technoton.com

Technoton regularly conducts tests for compatibility and joint accuracy of DFM with different models of terminals of popular brands. Table 7 shows the models of terminals compatible with DFM providing accuracy of joint measurement of fuel consumption not more than **1 %.**

Table 7 — Vehicle tracking terminals compatible with DFM

No.	Terminal			Analytical software
	Brand	Trade Mark	Model	
1	mapon	MapOn	GBOX6	MapOn web server
2	EcoTelematics Group	NaviFleet	ET100	NaviFleet
3	LOCARUS	Locarus	702X	LocarusInformer
4			702R	
5			702S	
6	СКАУТ	SCOUT	MT-530	Scout Explorer
7			MT-600 GP PRO	
8	СИБ ВЯЗЬ	Naviset	GT-10	GPS-Trace Orange
9	ВСЕ	VSE	Fm Light	Wialon
10	ritm GSM	VOYAGER	2	RITM-PCN
11	ГЛОСАВ	GLOSAV	BK11-02	GLOSAV
12	ТехноКом	Autograf	GSM+	AutoGRAF
13	Ruptela MOBILE SOLUTIONS	Ruptela	FM-Pro3	Trust-Track web server

Relevant information about the compatibility of specific terminal and DFM models and recommendations for their connections and setups can be found at www.jv-technoton.com

1.8 DFM selection

IMPORTANT! Final decision on applicability of a particular model of a fuel flow meter for a particular vehicle must be made by an installation specialist after inspection of a vehicle.

1.8.1 Selection depending on the engine power (boiler output)

DFM selection depending on engine power (boiler output) is performed in accordance to Table 8.

Table 8 — DFM selection depending on the engine power (boiler output)

Engine power, kW	Boiler output, kW	Recommended models
up to 80	up to 400	**DFM 50C** **DFM 50AK** **DFM 50CK**
from 80 to 150	from 400 to 800	**DFM 100C** **DFM 100AK** **DFM 100CK**
from 150 to 300	from 800 to 1500	**DFM 250C** **DFM 250AK** **DFM 250CK**
from 300 to 600	from 1500 to 3500	**DFM 500C** **DFM 500AK** **DFM 500CK**

1.8.2 Selection depending on the fuel flow in the supply and return lines of the engine

Selection of the **differential** DFM depends on fuel consumption values in the supply and return lines of the engine according to Table 9.

Table 9 — Selection of the differential DFM depending on fuel consumption values in supply and return lines

Minimum consumption, l/h	Maximum consumption, l/h	Recommended differential fuel flow meters
10	100	**DFM 100D**
25	250	**DFM 250D**
100	500	**DFM 500D**

ATTENTION!

1 Maximum and minimum fuel consumption values in supply and return lines of the engine can be found in the performance specification of the booster pump of the engine mounted on the vehicle.

2 Installation of a differential DFM on the fuel system with high performance pump and engine with small fuel consumption is not recommended. For example, the booster pump performance is 300 l/h, fuel consumption in idle run mode is 5-6 l/h, and relative fuel measurement error in supply and return lines is 1 %, absolute error value of differential measurement is up to 6 l/h. That is comparable with the amount of fuel consumed by the engine.

3 Counter indication to install a differential fuel flow meter is the fact of air presence in the supply or return fuel lines.

2 Installation and setup

This chapter contains main DFM installation recommendations.

2.1 External examination before start

Before the work starts external inspection of a DFM must be done for possible defects detection that could arise during transportation, storage or careless handling:

visible damage of the body, connecting elements, the mounting plate, the display, pilot cable and the socket;

backlash of components relative to one another and gaps between them.

If defects are found please contact your supplier.

2.2 Assessment of the vehicle condition

Before DFM installation the vehicle condition must be assessed and conclusion made on possibility to install DFM.

Assessment of the vehicle includes the following sequence:

1 Start the engine and check its operation for 5-10 minutes at idle and 5-10 minutes in movement under load. The engine must run evenly, not stall under load, loss of power must not be felt.

2 Inspect all fuel pipes of the vehicle for damage and fuel leakage.

3 Check system voltage with a voltmeter. Onboard 12 V power system must have voltage in the range from 10 to 18 V. Onboard 24 V power system must have voltage in the range from 18 to 32 V.

4 Check the amount of excess fuel removed from injectors through the return line. With a significant amount of excess fuel measurement error increases as the excess fuel gets back into the tank and DFM fuel flow meter counts it again.

5 Check pressure in the fuel line with a pressure gauge. Hydraulic resistance of a selected DFM, at nominal consumption, must not lower the pressure by more than 5 % in the fuel system.

6 Check the quality of the chassis of the vehicle. Resistance between any point of the chassis and the negative clamp of the battery should not exceed 1 Ohm.

According to the results of the check, a **Vehicle Inspection Report** must be filled in and signed (see Appendix B).

Before DFM installation, the owner of the vehicle has to eliminate any malfunctions filled in the Inspection Report.

2.3 General installation instructions

ATTENTION! This chapter provides particular cases of the engine operation scheme. Read carefully the technical documentation of the vehicle where you want to install a fuel flow meter in order to make a decision on applicability of the meter on this particular vehicle.

In order to install the fuel flow meter you will need the following:

- a DFM;
- a mounting kit (sold separately);
- a bracket (sold separately). In some cases DFM installation can be carried out without a bracket;
- automobile hand tool kit (cap key, drive socket and screw driver sets).

A DFM can be mounted in any position: vertical, horizontal or tilted. Sharp bends of cable and fuel pipes must be avoided when mounting.

ATTENTION! When fitting the mounting plate of the DFM **vehicle frame drilling is prohibited!** If fitting of the mounting plate is impossible with bolts, **spot welding** is allowed.

The following **rules** must be observed when mounting:

1 Vehicle fuel lines must be protected from any external damage.

2 It is prohibited to reduce internal dimension of the fuel pipes on bends.

3 Mounting of the fuel pipes of the vehicle should be made with buckles every 0.5 m.

4 Fuel pipes need to have some spare length in order to compensate length changes due to the temperature.

5 DFM installation on the elements of the vehicle subject to heating or vibration in not recommended.

6 When connecting fuel pipes, flanges and threaded connections must be clean.

7 When installing, only **new** copper sealing washers from a mounting kit have to be used.

8 Rubber fuel pipes must be connected to the elements of the fuel system using drive type nipples or direct flow fittings and secured with hose clamps or with crimping coupling of necessary diameter.

9 After DFM installation, it is necessary to remove air from the fuel system.

ATTENTION!
1 To measure fuel consumption with a single-chamber DFM, make sure that only amount of fuel necessary for the engine has to flow through the DFM. In order to follow that requirement, it often requires changing return fuel line (see 2.4.2 and 2.4.3).
2 If foam is present in the return pipe, installation of fuel deaeration system is required. To remove air bubbles and prevent them from getting into the fuel line, use a **deaerator** (see Figure 16).

Figure 16 — Deaerator

2.4 Fuel flow meters mounting schemes

2.4.1 Typical diesel engine fuel system scheme

The most common scheme of the fuel system of diesel engine is shown in Figure 17.

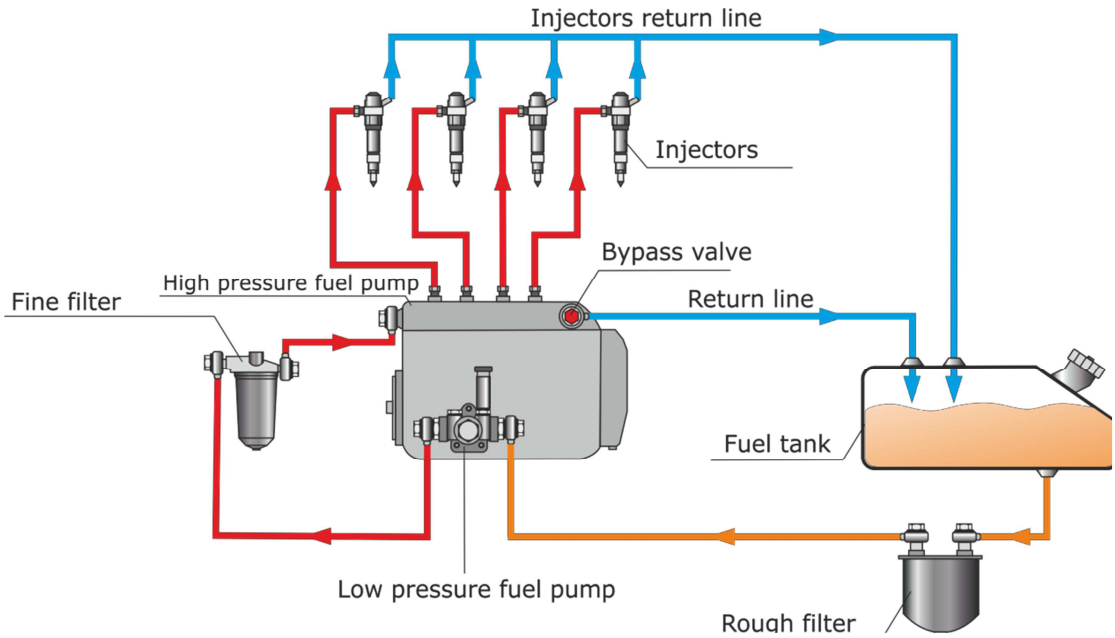


Figure 17 — Typical fuel system scheme

The low pressure fuel pump pumps significantly more fuel to the input of the high pressure fuel pump than the engine needs in any operation mode. Excess fuel from the high pressure fuel pump and injectors flows back to the fuel tank.
One peculiarity of automobile operation is uneven fuel consumption. Besides that hydraulic shocks can cause errors in DFM work. In order to compensate hydraulic shocks at the fuel flow meter it is **recommended to install a non-return valve after the DFM**.

2.4.2 DFM installation before the pump

DFM installation according to Before the Pump scheme involves installation of a fuel flow meter in the part of the fuel system where the flow of fuel is carried out due to depression created by a low pressure fuel pump.

ATTENTION! DFM installation before the pump requires compulsory use of additional fine filter on the line from the tank to the DFM.

Particular case of DFM installation according to Before the Pump scheme:

In order to install a DFM in the fuel system with a low pressure fuel pump (see Figure 18) according to this scheme, it is necessary to use the line between the rough filter and the low pressure fuel pump input.

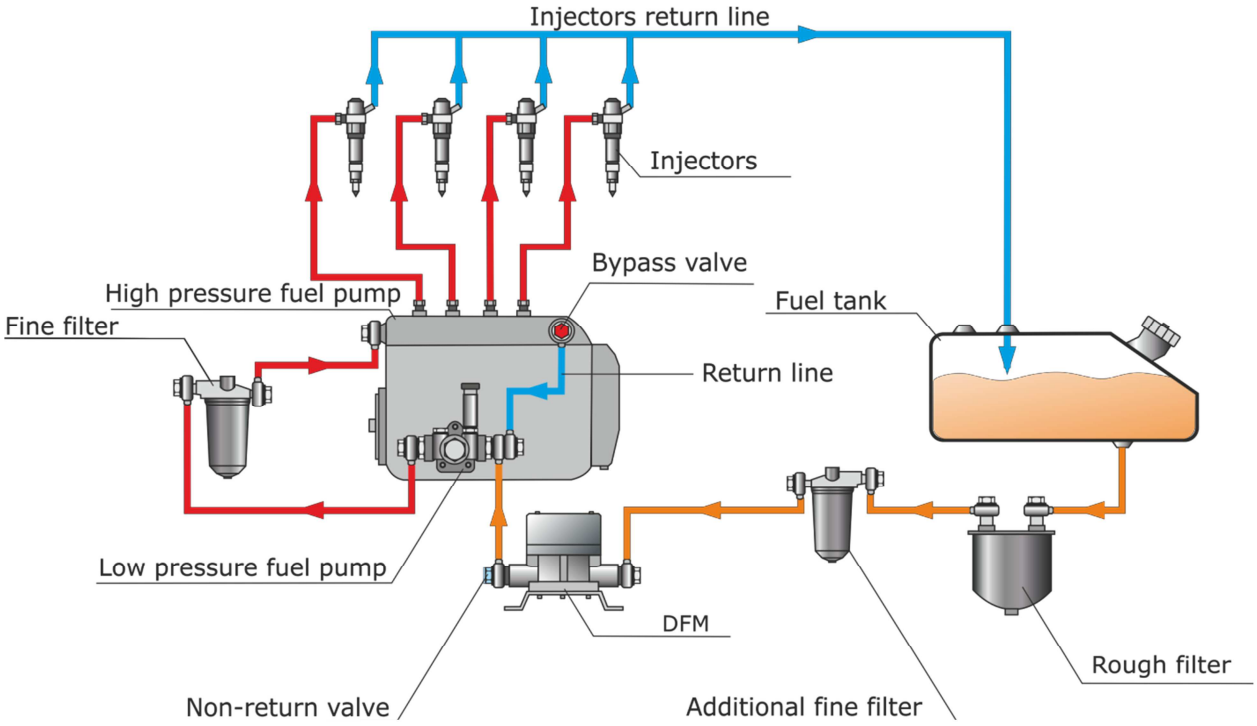


Figure 18 —DFM installation according to Before the Pump scheme with a low pressure pump

When injectors operate correctly their return flow is less than 0.1 % of fuel consumption, and therefore this can be negligible.

In order to prevent measuring of the fuel returns back to the tank, it is necessary to make changes in the return line.

In this particular case the return line from the high pressure fuel pump has to be modified in such way that fuel could circulate in a small circle without fuel tank participation. It can be done by connecting return line of the high pressure fuel pump with low pressure fuel pump input.

Thus fuel from two lines flows to the low pressure fuel pump input:

1) from the fuel tank through DFM flow meter;
2) from high pressure fuel pump return line.

For proper operation of the modified fuel system install a bypass valve at the high pressure fuel pump output, which will support necessary constant pressure of 1-1.5 atmosphere. At DFM output a 0.35-0.5 atmosphere non-return valve has to be installed which will prevent fuel flow in the opposite direction and will reduce fuel system's hydraulic shocks at the DFM.

After the fuel system is modified according to depression scheme, all excess fuel pumped by the low pressure fuel pump will be directed from the high pressure fuel pump output to low pressure fuel pump input.

Thus only the fuel that is consumed by the engine flows through the DFM.

ATTENTION! One of advantages when excess fuel returns back to the tank is fuel heating in the tank. Therefore, when a vehicle is used in low temperature environment, it is not recommended to modify the fuel system. Use differential DFM flow meters instead or install a fuel heater.

In order to install DFM according to Before the Pump scheme without low pressure pump (see Figure 19), it is necessary to use the line between a rough filter and a bypass valve of the high pressure fuel pump. At the same time installation of additional fine filter between the rough filter and DFM is necessary.

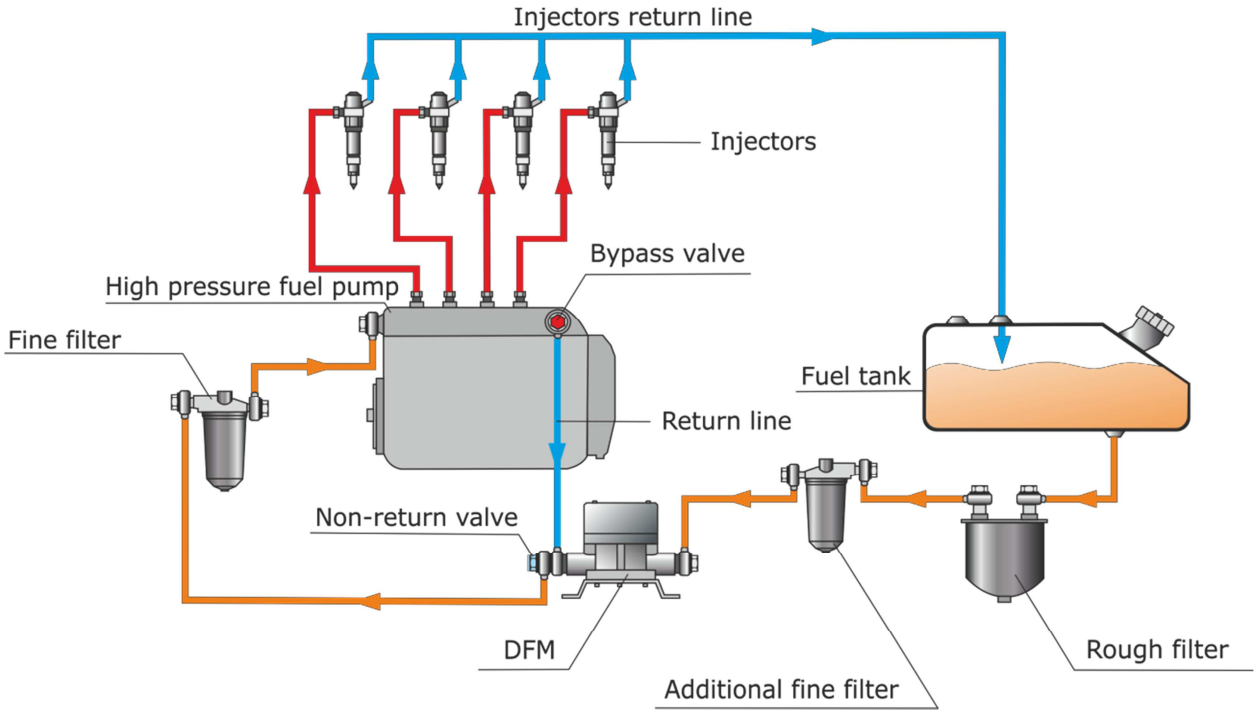


Figure 19 — DFM installation according to depression scheme without a low pressure pump

Advantages of Before the Pump scheme:

- Minimal interference into the fuel system;
- Simple installation;
- Applicable for most engines.

Disadvantages of the scheme:

- requires installation of an additional fine filter and causes additional costs;
- additional load on the low pressure fuel pump;
- fuel is not heated in the tank by return flow line (it sometimes requires fuel heater installation).

2.4.3 DFM installation after the pump

DFM installation after the pump involves installation of flow meter in the line after the low pressure pump where fuel flows under pressure.

Particular case of DFM installation according to After the Pump scheme:

In order to install DFM according to pressure scheme in the fuel system with LPFP (see Figure 20), it is necessary to use the line between fine filter and high pressure fuel pump input.

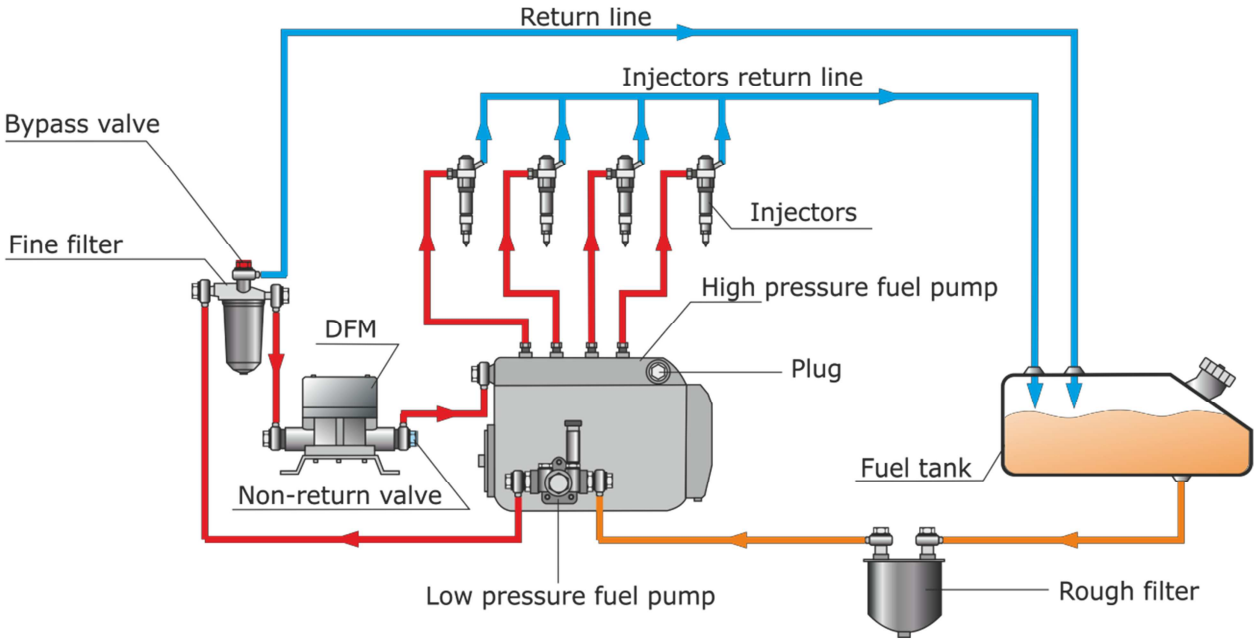


Figure 20 — DFM installation according to After the Pump scheme

Return flow from the high pressure fuel pump has to be modified to fuel circulation in a small circle without fuel tank involvement i.e. the return line needs to be moved from high pressure fuel pump output to fine filter input, and high pressure fuel pump output needs to be plugged.

For correct operation of modified fuel system a bypass valve has to be installed at the fine filter input which will support necessary constant fuel pressure at 1-1.5 atmosphere in the

line between the fine filter and high pressure fuel pump input. Install a 0.35-0.5 atmosphere non-return valve at the DFM output to prevent fuel flow through the DFM in the opposite direction. This will decrease fuel system hydraulic shocks at the DFM.

Thus, excess fuel pumped by low pressure fuel pump will be dropped back to the fuel tank from fine filter's side; and only amount of fuel consumed by the engine will flow through the flow meter.

Advantages of After the Pump scheme:

- DFM is installed after a regular fine filter;
- Fuel flows under pressure and doesn't overload the low pressure fuel pump;
- Return fuel flow can heat fuel in the tank.

Disadvantages of After the Pump scheme:

- High pressure fuel pump is slightly deteriorated;
- Return flow fuel temperature is lower than with a regular fuel system.

2.4.4 Differential DFM installation scheme

ATTENTION! Differential fuel flow meters installation in fuel systems with high performance low pressure fuel pump and small fuel consumption is not recommended due to increase of measurement errors higher than allowed (see Table 1).

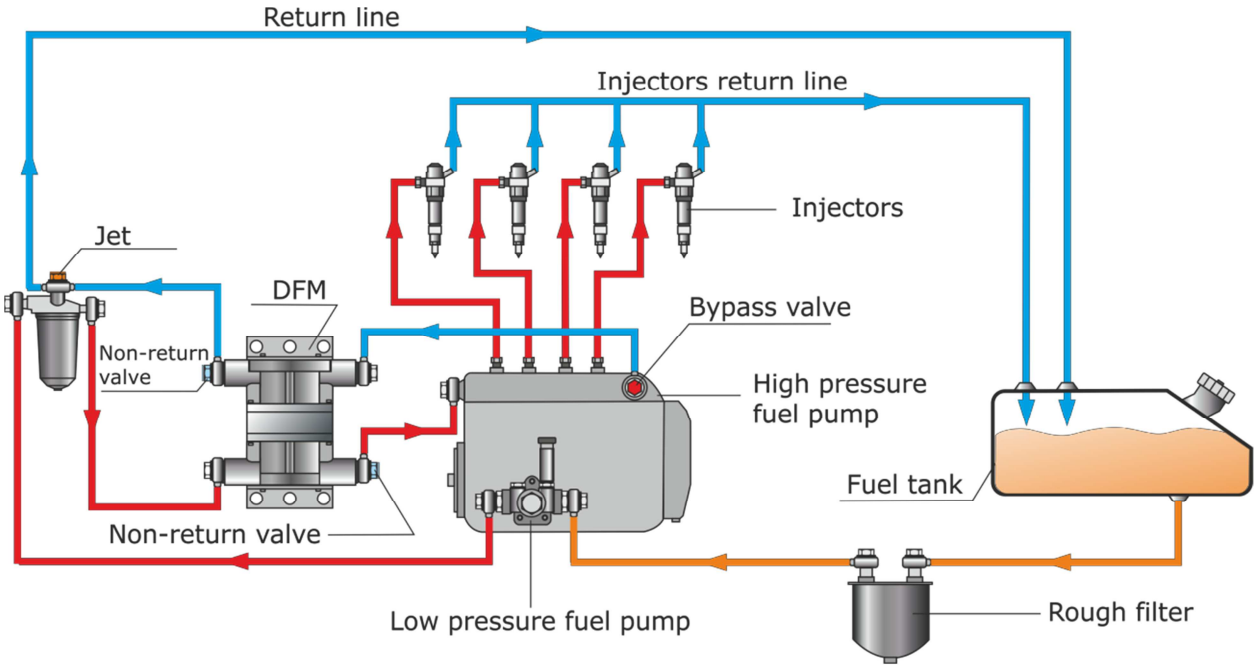
Fuel circulation in the fuel system doesn't change with differential measurement. Straight-flow chamber of differential DFM is to be installed in the gap of supply fuel line of the engine. Return-flow chamber is to be installed in the gap of the return line. Fuel consumption is calculated as a difference of measured values of fuel flows in straight-flow and return-flow chambers.

Particular cases of differential DFM installation scheme:

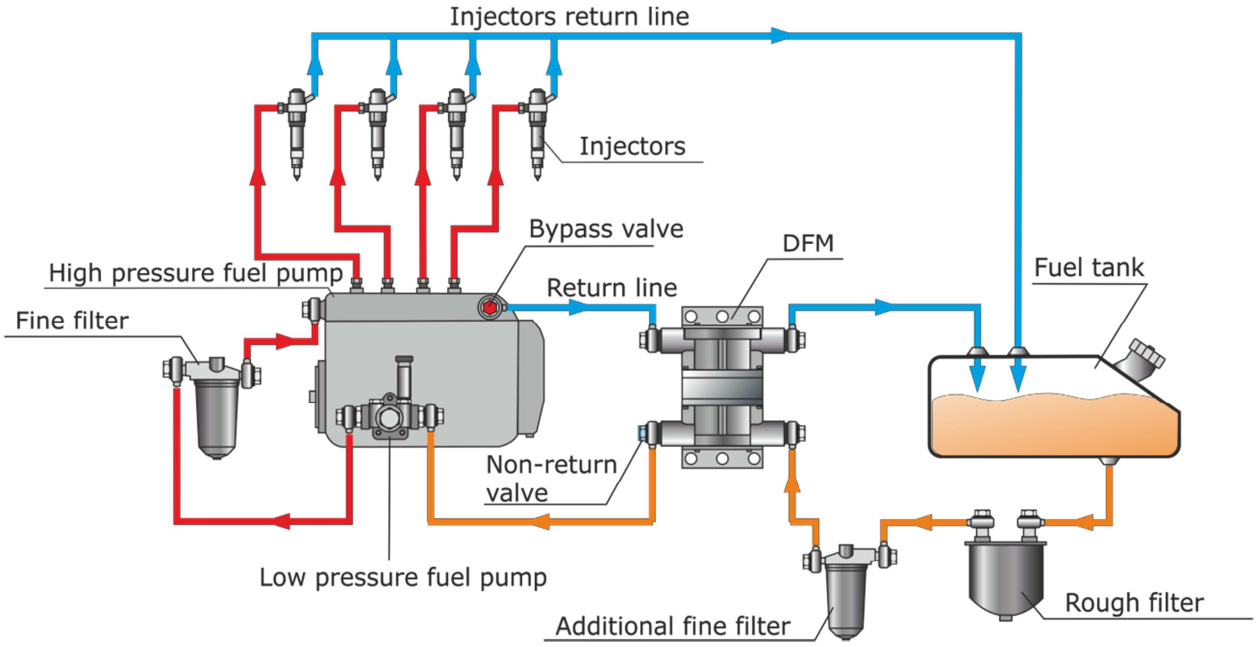
1) Installation of the feed chamber is made after the low pressure fuel pump (**After the Pump scheme**) (see Figure 21a).

2) Installation of the feed chamber is made before the low pressure fuel pump (**Before the Pump scheme**). In this case additional fine filter installation is required (see Figure 21b).

Return-flow chamber of differential DFM in both cases is to be installed in return line between high pressure fuel pump output and the fuel tank.



a) The feed chamber installation after the pump



b) Feed chamber installation before the pump

Figure 21 — Differential DFM installation scheme

Advantages of differential installation scheme:

- no changes in the fuel system;
- installation possible for engine during warranty period.

Disadvantages of differential installation scheme:

- higher cost;
- higher fuel consumption measurement error;
- additional fine filter and DFM increase load on the low pressure fuel pump.

2.5 Electrical connection

Fuel flow meters with interface cable (**DFM AK, DFM CK, and DFM D**) are supplied with electrical power from onboard vehicle power source.

ATTENTION!
1 When connecting DFM to onboard power source it is necessary to connect feed "+" and chassis "-" wires to the same sockets where appropriate wires of recording and display devices are connected.
2 Before starting electrical connection of the sensor special attention must be paid to the quality of the chassis. Resistance between any point of the chassis and the negative clamp of the battery must not exceed 1 Ohm.
3 It is **strictly recommended** to lay DFM pilot cable together with standard electrical wiring of the vehicle with mandatory fixing with buckles every 50 cm (see Figure 22).

Figure 22 — Laying the DFM pilot cable

DFM electrical connection is made in accordance with the purpose of the interface cable (see Table 10).

To connect DFM power supply wires it is recommended to use **terminals** (see Figure 23a), and to connect pilot cable wires it is recommended to use **connectors** (see Figure 23b).

a) terminals b) connectors

Figure 23 — Terminals and connectors to connect DFM

Table 10 — Wire assignment in the plug of the DFM interface cable

Wire marking	Wire color	Wire assignment
OUT	White	Pulse signal (see 1.6.8)
GND	Brown	Chassis "-"
VBAT	Orange	Feed "+"

2.6 DFM adjustment

DFM fuel flow meters are supplied ready to use and require no configuration. The manufacturer calibrated all DFMs for diesel fuel. In the DFM registration certificate is specified the number of pulses of the output signal that corresponds to 1 liter of fuel flowing through the flow meter.

When DFM is used in GPS/GLONASS vehicle tracking and fuel monitoring system, interface cable of the fuel flow meter is connected to the pulse input of the tracking device (terminal). Certified value of the number of pulses per 1 liter is entered into the software configuration at the server of a vehicle tracking system.

2.7 Measurement accuracy check

To determine accuracy of measurements of DFM flow fuel meter installed in the vehicle it is necessary to carry out tests.

2.7.1 Test conditions

Representatives of interested parties should attend the test.

Persons who have studied DFM, electronic terminals operational documentation, and who have experience with testing equipment are allowed to conduct these tests.

Tests are conducted on operable vehicle.

Conditions for test flow:

1) Engine run time - not less than 1 hour
2) The engine must run at medium speed.
3) During the test engine shutdown is not allowed.
4) To check the amount of fuel it is necessary to use only proven measuring tanks.

2.7.2 Preparation for the tests

Install the fuel flow meter and connect it to recording and display devices. Conduct all works in accordance with the installation manuals for fuel flow meters and recording and display devices.

2.7.3 Conducting the tests

1) Pour fuel into tank 1. The amount of fuel must be enough to eliminate air from the fuel system and warm up the engine (see Figure 24).
2) Use a measuring tank to fill tank 2 with testing fuel in the amount of 10 liters.
3) Connect low pressure fuel pump input with fuel pipe 1.
4) Put into tank 1 the free end of fuel pipe 1.
5) Return flow fuel pipe 2 put into tank 1.
6) Disconnect the injectors return line from the fuel tank and put it into tank 1.
7) Use manual pump of the fuel pump to pump through the fuel system in order to remove all air.
8) Start the engine and let it warm up to operating temperature. At the same time make sure there is no air coming out from return fuel pipe 2.
9) Simultaneously close inlets of fuel pipes 1 and 2 and stop the engine.
10) Move fuel pipes 1 and 2 from tank 1 into tank 2 (the air must not get into the hoses).
11) Close inlet of injectors return fuel pipe 3 and move it from tank 1 into empty tank 3.
12) Record the initial readings of the DFM according to the readings of a tracking device or the DFM display.
13) Record the time when the test was started.
14) Start the engine and set medium run.
15) Let the engine run until tank 2 is empty. At the same time air cannot be let into fuel pipe 1.
16) Stop the engine.
17) Measure the fuel left in tank 2 (V_{remain}).
18) Use measuring tank to measure **actual fuel consumption** from tank 2 (V_m=10 l–V_{remain}).
19) By difference of initial and final DFM readings determine **measured fuel consumption** ($V_{measured}$).

20) Calculate the **relative measurement error of fuel consumption** by the formula:

$$\delta = \frac{Vmeasured - Vm}{Vm} \cdot 100 \text{ , \%}$$

where $V_{measured}$ – measured fuel consumption, l;

V_m – actual fuel consumption, l.

21) Use measuring tank to determine **actual fuel amount from injectors return line** ($V_{inj.return}$);

22) Determine the **proportion of the return flow from the injectors in overall fuel consumption** for a tested vehicle by the formula: $\frac{V_{inj.return}}{Vm} \cdot 100$;

23) Document test result into the protocol. Protocol form is in Appendix C.

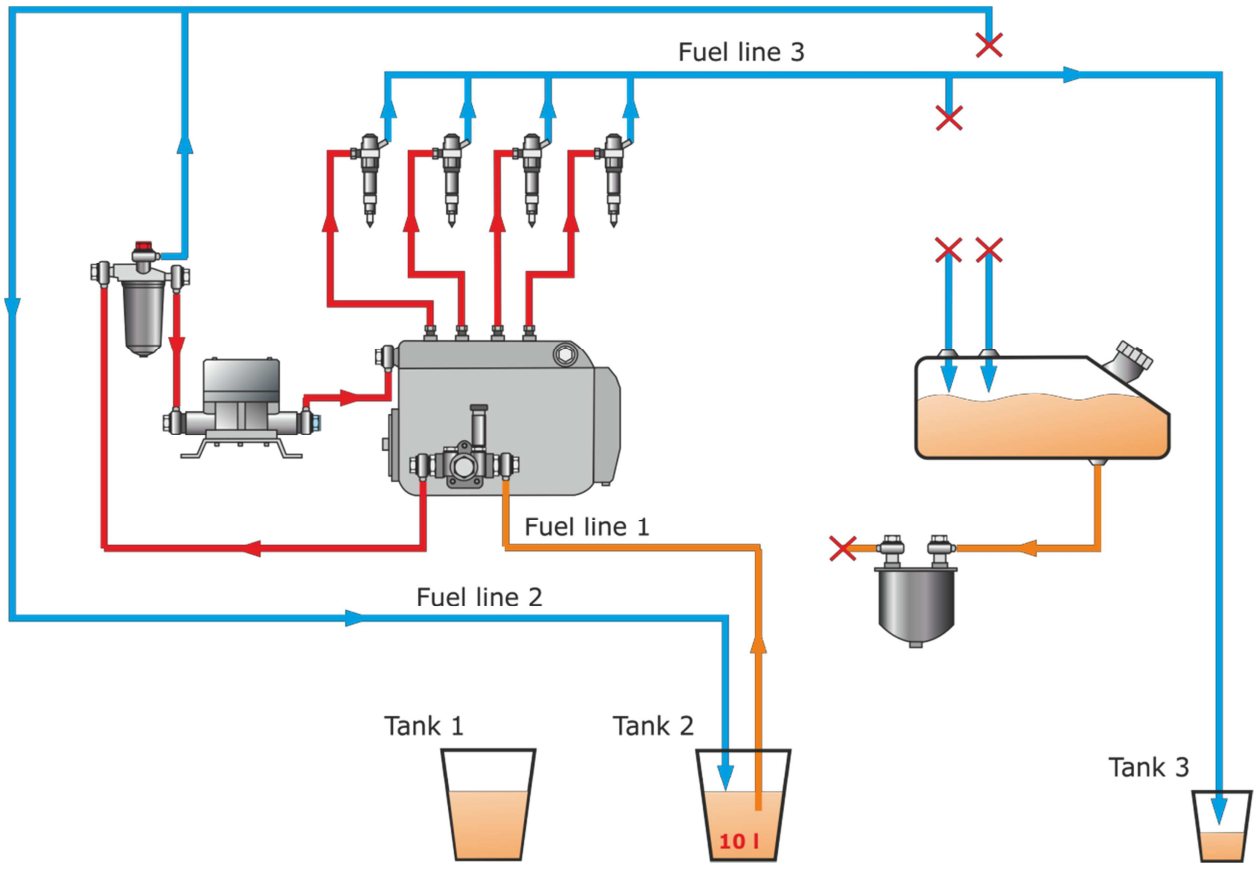


Figure 24 — Fuel system scheme during test

2.8 Accessories

To install, connect, and operate DFM fuel flow meters, Technoton offers **high quality accessories.**

2.8.1 Mounting kits

DFM mounting kits (hereinafter referred to as MK DFM) are designed to connect fuel flow meters to the engine fuel system using pipes with diameters of 8 mm and 10 mm.

MK DFM use only high quality components designed for use in the fuel system of vehicles.

Distinctive features of MK DFM

- manufacturing material - steel;
- manufacturing technology - hot stamping;
- coating - zinc;
- enlarged orifice;
- no burrs or shavings;
- connecting pipes, valves, bolts of the drive type nipples have holes for sealing.

Selection of a MK DFM is carried out in accordance with Table 11.

Table 11 — MK DFM application

Kit Indication	Application
DFM Kit2	Universal, to install single-chamber flow meters using Ø 8 mm pipe
DFM Kit4	Universal, to install single-chamber flow meters using Ø 10 mm pipe
DFM Kit5	Universal, to install DFM 500 single-chamber flow meters using Ø 10 mm pipe
DFM Kit10D	To install differential fuel flow meters DFM 100D and DFM 250D using Ø 10 mm pipes
DFM Kit20D	To install DFM 500D differential fuel flow meters using Ø 10 mm pipe

DFM Kit composition (see Table 12) has been selected on the basis of many years of experience of installing fuel flow meters on various types of machinery.
There are differences in compositions of DFM Kit for differential and single-chamber flow meters depending on an installation scheme and engine features of a vehicle.

Table 12 —DFM Kit composition

External appearance	Label	Description	Kit label						
1	2	3	2	4	5			10D	20D
	Banjo bolt BB 14	To couple the fuel line and the fuel flow meter to the units of the fuel system – the high pressure fuel pump or the fine filter	3	3	2			6	4
	Banjo bolt BB 16		-	-	1			-	2
	Banjo bolt double BB 14/2	To couple 2 branches of the fuel system to the units of the fuel system – the high pressure fuel pump or the fine filter	1	1	1			-	-
	Banjo fitting BF 14/8	To connect ø 8 mm pipe to mounting elements	8	-	-			-	-
	Banjo fitting BF 14/10	To connect ø 10 mm pipe to mounting elements	-	8	6			8	4
	Banjo fitting BF 16/10		-	-	2			-	4
	Non-return valve K10	To remove the hydraulic shocks influence on the measurement accuracy of the flow meter (white valve)	1	1	-			2	-
	Non-return valve K15		-	-	1			-	2

Table 12 continued

1	2	3	2	4	5			10 D	20 D
	Bypass valve K20	To release excessive pressure in the fuel line at the output of the booster pump	1	1	1			-	-
	Bolt plug BP14	To plug the high pressure fuel pump hole to the return line	1	1	1			-	-
	Nipple adapter NA 14-4	To connect the fuel line with a return fuel line through the bypass valve	1	1	1			-	-
	Nipple adapter NA 14-20	To reverse the return fuel line from the fine filter via the bypass valve	1	1	1			-	-
	Nipple adapter NA 10-14	To connect the fuel line and heater tube	1	1	1			-	-
	Nipple adapter double NA 10-14/2	For joining two fuel lines with heater line	1	1	1			-	-
	Copper washer CW 14-19	To seal connections	16	16	12			16	8
	Copper washer CW 16-21	To seal connections	-	-	4			-	8
	Copper washer CW 20-26	To seal connections on the fine filter of YaMZ engines	1	1	1			-	-
	Hose clamp HC 10-16	To fix ø 8 mm fuel hose onto the angle joint or filter	8	-	-			-	-
	Hose clamp C 12-22	To fix ø 10 mm fuel hose onto the angle joint or filter	-	8	8			8	8

Table 12 continued

1	2	3	2	4	5			10 D	20 D
	Bolt B8x16	To mount the flow meter to the bracket	4	4	4			4	4
	Nut N8	To mount the flow meter to the bracket	4	4	4			4	4
	Washer W8	To mount the flow meter to the bracket	4	4	4			4	4
	Lock washer WL8.65	To mount the flow meter to the bracket	4	4	4			4	4

ATTENTION! The manufacturer reserves the right to make changes to the DFM kits, and replace components with similar ones without notifying the customer.

2.8.2 Connecting cable

For electrical connection the fuel flow meters to the interface output connection cables are used in accordance with Table 13.

Table 13 — DFM connecting cable

External appearance	Indication (label)	Purpose and description
	Flow meter cable	Designed to connect a flow meter to recording and display devices and to external power supply ***Supplied with all interface fuel flow meters.***

2.8.3 DFM fuel consumption readout unit

When using fuel flow meters with interface cable (**DFM AK, DFM CK, DFM D**), a device that registers and indicates information on fuel consumption, engine operation time, or any other fuel consumer may be needed. To implement those functions, a fuel counter, DFM-I (hereinafter referred to as indicator), was designed by Technoton JV (see Figure 25).

Figure 25 — DFM fuel consumption indicator

The indicator can be installed in a cab or in any other location convenient for reading.

The indicator displays an extended set of information according to 1.6.6.

Model specifications of indicators are shown in Table 14.

Table 14 — DFM fuel flow meters indicators model specifications

Model	Pulse rate, ml/pulse	Flow measuring range, l/h	$R_{input\ mod}$*, kOhm, not less than	Operating temperatures range, C	Weight, kg, not more than	Dimensions (excluding harness), mm, not more than
DFM i5	5	from 1 to 100	50	from -20 to +60	0.3	75x60x30
DFM i12.5	12.5	from 5 to 250				
DFM i20	20	from 10 to 500				
* Input resistance of the measuring input of the indicator.						

More detailed information about DFM fuel consumption indicator is in **DFM fuel consumption indicator. User Manual** document.
The latest version of this document can be downloaded at www.massflow-online.com

3 Diagnostics and troubleshooting

In case of DFM fuel flow meters malfunction, please contact your supplier.

DFM repair works can be carried out only by certified regional service centers. Full list of service centers can be found at www.jv-technoton.com

Some self-help troubleshooting is allowed (see Table 18).

Table 18 — DFM flow meters malfunctions when self-help troubleshooting is allowed

Malfunction	Model	Possible reason	Troubleshooting method
No output signal	**DFM AK** **DFM CK** **DFM D**	Incorrect connection	Check if the flow meter is connected to the recording and display devices
		Fuel filter plugging	Remove and clean the fuel filter
Fuel doesn't flow through the fuel flow meter	**DFM C** **DFM CK**	Fuel filter plugging	Remove and clean the fuel filter
Overrated fuel consumption	**DFM C** **DFM AK** **DFM CK** **DFM D**	Wrong fuel flow meter selection or error in the installation scheme	Study the technical documentation of the engine and check the connection scheme
		Hydraulic shocks in the fuel system	Install a return valve after the flow meter or check its operability if the return valve is installed

4 Evaluation

At product release each DFM flow meter passes departmental metrological evaluation on metrological certified automatic test installations.

Any DFM delivery package contains a verification certificate that serves as a confirmation of its departmental metrological evaluation.

5 Maintenance

It is recommended to perform visual inspection and DFM operation check at least once a year.

In order to provide DFM operability, it is recommended to remove and clean the mud filter from time to time (see Figure 28).

Figure 28 — Mud filter

ATTENTION! When you remount DFM, replace used copper washers with new ones.

6 Storage

It is recommended to store DFM in enclosed dry rooms.

DFM storage is allowed only in original packaging at temperature from -50 to +40 °C and relative humidity up to 100 % at 25 °C.

It is prohibited to store DFM in the same room with chemicals that cause metal corrosion and/or contain corrosive agents.

DFM storage period must not exceed 24 months.

7 Transporting

DFM can be transported in any kind of enclosed vehicle which can provide protection from physical damage and package from precipitations.

Air quality in vehicles must not contain acid, alkaline, and other corrosive contaminants.

Shipping containers with DFMs packed should be sealed.

8 Disposal

DFM doesn't contain harmful agents and components that are hazardous to human health and the environment during its lifetime and after disposal.

DFM does not contain precious metals in amounts required for accounting.

Contact information

Distribution and first line of support

Mass Flow ONLINE BV
support@massflow-online.com

Distribution, technical support, service

Technoton JV

Phone/fax: +375 17 223 78 20

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support@technoton.by

Manufacturer

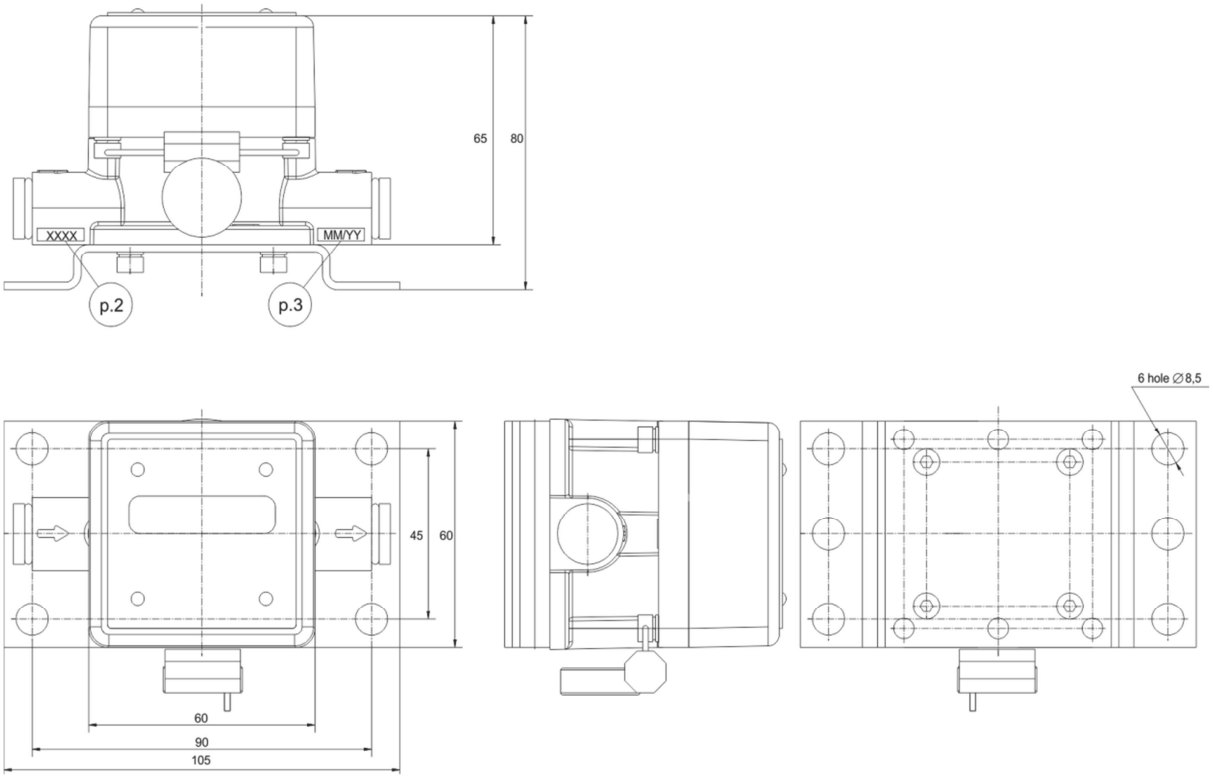
Zavod Flometr

office@flometr.by

Appendix A

Dimensions and weight

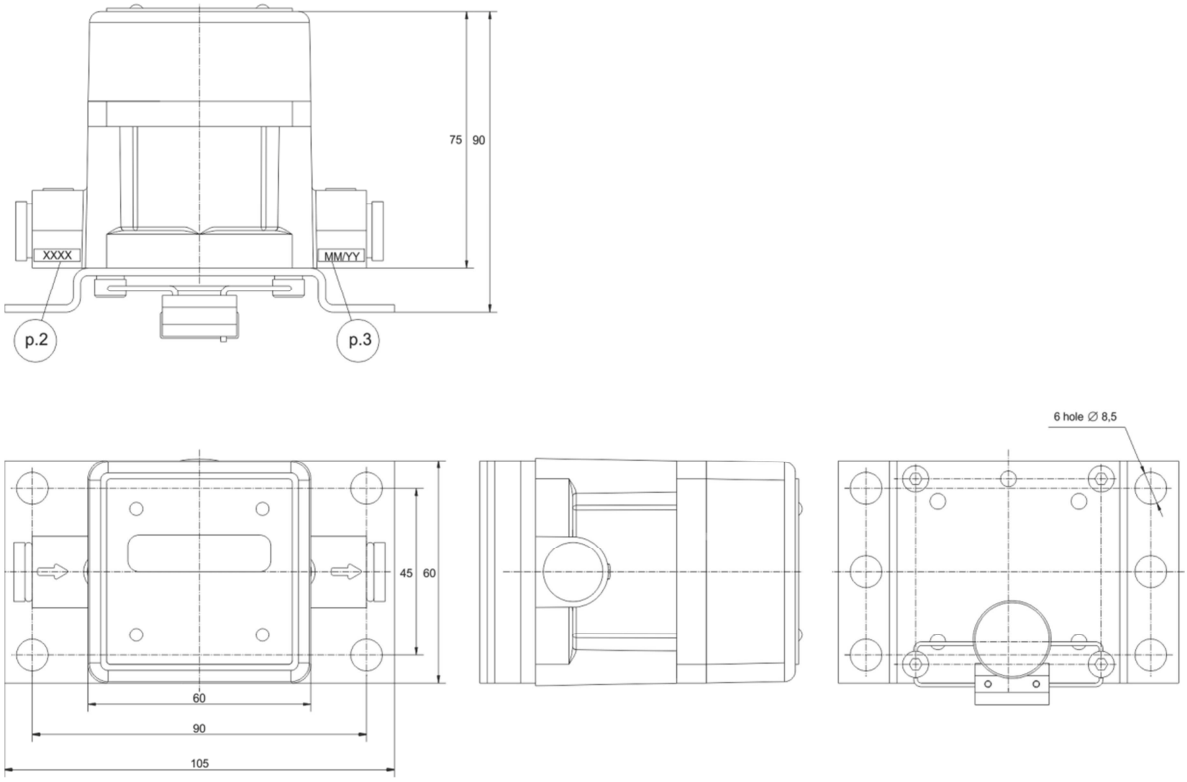
DFM 50C and DFM 100C



1. Dimensions for reference.
2. Serial number (xxxx).

Appendix A continued

DFM 250C and DFM 500C



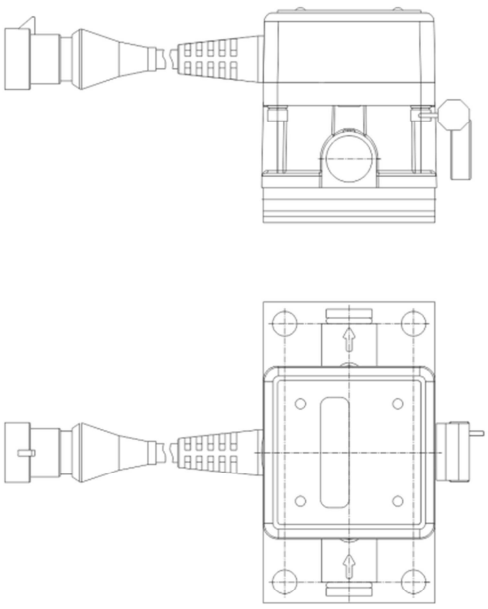
1. Dimensions for reference.
2. Serial number (xxxx).

Appendix A continued

Appendix A continued

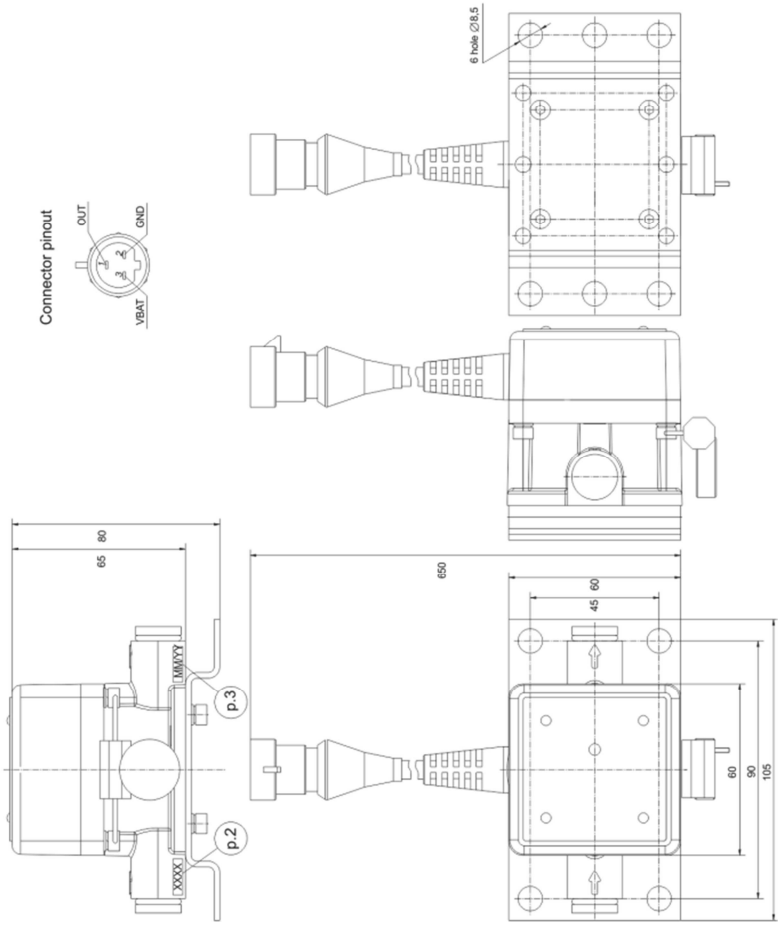
Appendix A continued

DFM 50CK, DFM 100CK



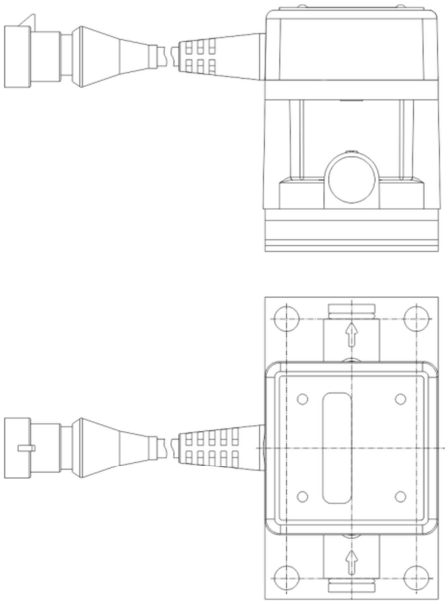
1. Dimensions for reference.
2. Serial number (xxxx).
3. Production date (MM/YY).

DFM 50AK, DFM 100AK



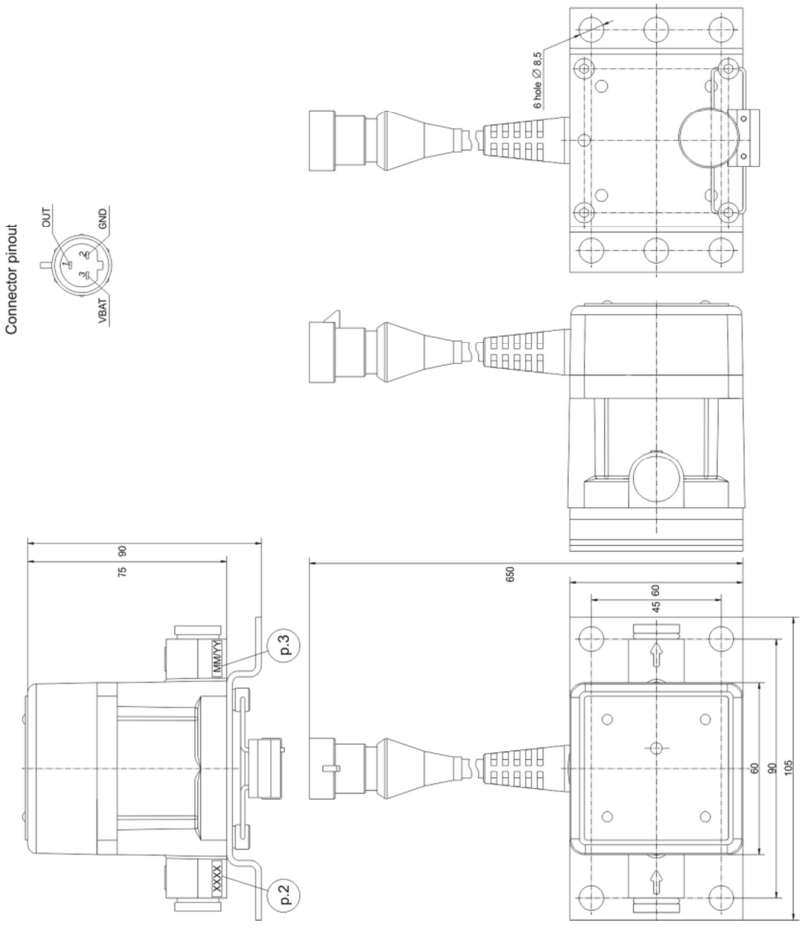
Appendix A continued

DFM 250CK, DFM 500CK



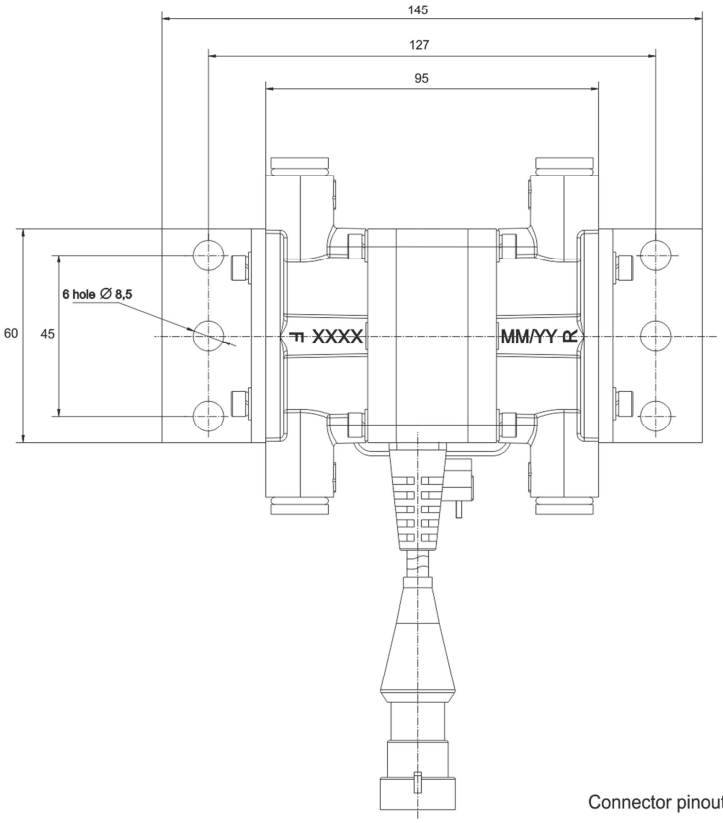
1. Dimensions for reference.
2. Serial number (xxxx).
3. Production date (MM/YY).

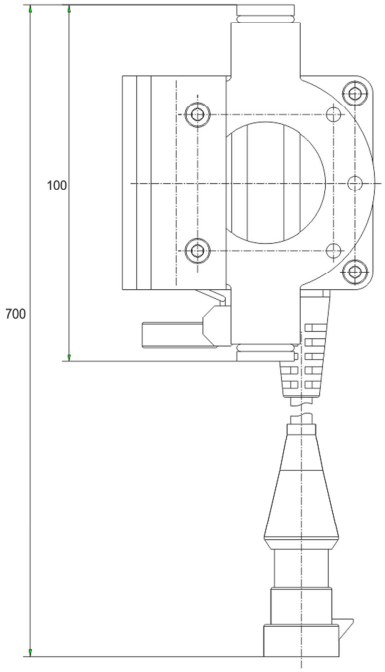
DFM 250AK, DFM 500AK



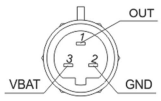
Appendix A continued

DFM 100D





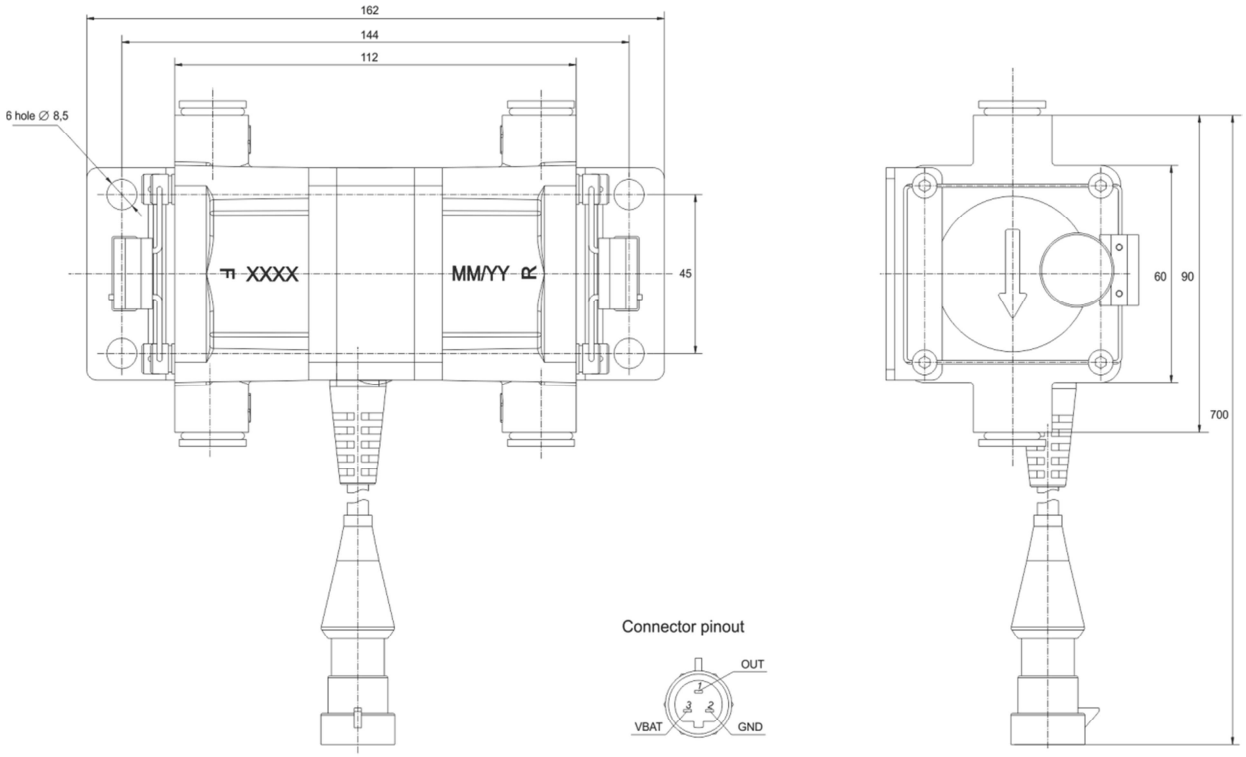
Connector pinout



1. Dimensions for reference.
2. Fuel flow direction (F - feeding, R - return)
3. Serial number (xxxx).

Appendix A continued

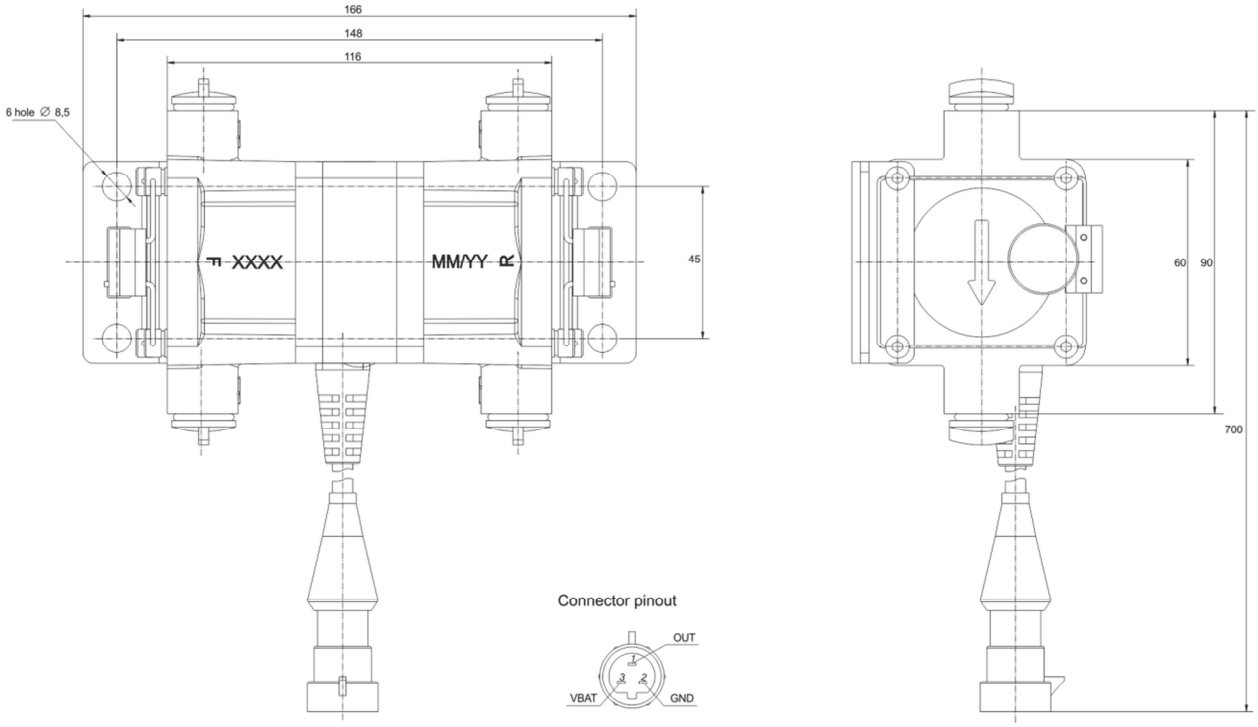
DFM 250D



1. Dimensions for reference.
2. Fuel flow direction (F - feeding, R - return)
3. Serial number (xxxx).

Appendix A continued

DFM 500D



1. Dimensions for reference.
2. Fuel flow direction (F - feeding, R - return)
3. Serial number (xxxx).

Table A.1 — DFM weight

Model	Weight, kg
DFM 50AK **DFM 50C** **DFM 50CK**	0.8
DFM 100AK **DFM 100C** **DFM 100CK**	
DFM 100D	1.7
	1.2
DFM 250AK **DFM 250C** **DFM 250CK**	
DFM 250D	2.4
DFM 500AK **DFM 500C** **DFM 500CK**	1.5
DFM 500D	3.3

Appendix B

Vehicle inspection report

_____ / _____ /20__
Date Month Year

We, the undersigned representatives of the Customer
_____,
and representatives of the Contractor
_____,
have conducted vehicle (installation) inspection

Vehicle type Brand, _____
model Registration _____
number _____

for conformity to DFM installation requirements, and have concluded the following:

Requirement	Conforms/ Does not conform	Notes
Leakage resistance of the fuel system		If there is leakage in fuel system, measurement accuracy and DFM performance is not guaranteed Fuel system repair to eliminate leaks is recommended
Fuel pressure in the system		If the fuel pressure is insufficient DFM performance is not guaranteed It is recommended to repair or do maintenance of the booster pump
Condition of the injectors return flow		Increased fuel consumption of injectors return flow can seriously affect measurement error. Maintenance work or replacement of the injectors is recommended
Onboard voltage		Insufficient voltage does not guarantee DFM performance Onboard circuit and/or of power generator repair is recommended
Condition of the chassis switch		Significant resistance / oxidation does not guarantee DFM performance Replacement of the chassis switch is recommended

Representative of the CUSTOMER: Representative of the CONTRACTOR:

_____ _____

Name, signature Name, signature

Appendix C

Calibration Protocol

_____ / _____ /20__

Date Month Year

Make, model, license number of the vehicle	
DFM model, serial number	

Fuel consumption	Actual fuel consumption. According to measurement tank V_m, l	
	Fuel consumption measured. According to DFM reading $V_{measured}$, l	
Relative measurement error of fuel consumption	$\delta = \frac{V_{measured} - V_m}{V_m} 100$, %	
Actual fuel amount from injectors return line	$V_{inj.return}$, l	
Proportion of the return flow from the injectors in overall fuel consumption	$\frac{V_{inj.return}}{V_m} 100$, %	

Conclusions

The fuel consumption measurement corresponds (does not correspond) to the technical specification.

Comments: _____
_____
_____
_____

Representative of the CUSTOMER /_____/

Representative of the CONTRACTOR /_____/